INDOOR AIR QUALITY ASSESSMENT

Nissitissit Middle School
33 Chace Avenue
Pepperell, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
June 2003

Background/Introduction

At the request of Ed Wirtanen, Health Agent for the Pepperell Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the newly constructed Nissitissit Middle School (NMS), Pepperell, MA. Pepperell School Department (PSD) officials informed BEHA staff that construction of the building had been completed prior to the 2002-2003 academic school year.

The school was visited by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality Program (ER/IAQ), BEHA, on May 9, 2003 to conduct an indoor air quality assessment. Accompanying Mr. Holmes were Mr. Wirtanen, Bill Kenison, Clerk of the Works and for portions of the assessment, Oscar Hills, Supervisor of Buildings and Grounds.

The NMS is a multi-level brick building constructed from 2000-2002. The upper level of the school contains general classrooms, science classrooms, an art room with kiln, a dark room and office space. The main level consists of the gymnasium, auditiorium, general classrooms, science classrooms, music rooms, media center, administrative offices, kitchen and cafeteria. The lower level contains general classrooms, science classrooms, the boiler room and maintenance shop.

Pursuant to an agreement with the architect and upon completion of the school an indoor air quality study was to be conducted to assess the NMS by a private consultant. The private consultant, Gordon Air Quality Consultants, Inc, (Gordon), completed an assessment in December of 2002 and made the following recommendations:

1. Inspect and clean univent interiors;

2. Consider conducting further air samples for mold identity and concentration;
3. Improve housekeeping/dust control;
4. Balance ventilation equipment by an HVAC engineering firm (Gordon, 2002).

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). Outdoor background TVOC measurements were taken for comparison to indoor levels.

Results

The school houses middle school students grades 7-8. It has a student population of approximately 560 and a staff of approximately 60-70. Tests were taken during normal operations at the school and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million parts of air (ppm) in all areas surveyed, with one exception. These carbon dioxide levels indicate adequate ventilation in the school. The one exception was in the music room, (room 244) where the roof top air-handling unit (AHU) was deactivated to prevent contaminants from a roof repair job from being entrained and subsequently

getting into the air stream in proximity to the school's main office (see **Other Concerns**). Fresh air in perimeter classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 1) and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit.

A univent was found deactivated in classroom 114. Mr. Kennison believed this univent was deactivated the week (April vacation) prior to the BEHA assessment so it could be cleaned and have the filters changed. The univent was reactivated by Mr. Kennison and it appeared to be operating correctly. Obstructions to airflow, such as books, papers, and desks were seen in a number of classrooms, as well as items in front of univent return vents. In order for univents to provide fresh air as designed, they must be unblocked and remain free of obstructions.

The mechanical exhaust ventilation system consists of ceiling and wall-mounted exhaust vents (see Picture 2). These vents were operating throughout the building, with the exception of classroom 211. Little or no draw of air was detected in this classroom (see Tables), which can indicate that either the exhaust ventilation was turned off or that the rooftop motor was not functioning. Without removal by the exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air complaints.

Ventilation for interior rooms throughout the building is provided by rooftop AHUs. Fresh air is distributed via ceiling-mounted air diffusers. Return air is ducted back to the unit by ceiling or wall-mounted exhaust vents. As previously mentioned, all

of the AHUs were operating during the assessment, with the exception of the unit servicing the music room. Science classrooms are equipped with an additional exhaust vent installed to facilitate ventilation during science experiments.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. School officials stated that balancing operations were on going during the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air

(ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix I.

Temperature measurements ranged from 71° F to 79° F, which were within or slightly above the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature control complaints (excessive heat) were expressed to BEHA staff in the guidance suite (see Tables); school maintenance officials were working to resolve this issue with the school's HVAC contractor. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 29 to 41 percent, which was below the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low

relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water-damaged ceiling tiles which can indicate leaks from either the roof or plumbing system. School maintenance officials reported several areas with active leaks and are currently working with roofing contractors to identify the sources for repair. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants should be equipped with drip pans; the lack of drip pans can lead to water pooling and mold growth on windowsills (see Picture 3). Plants are also a source of pollen. Plants in several classrooms were noted near univent air diffusers (see Picture 4). Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Several rooms contained aquariums with standing water (see Picture 5). Aquariums should be properly maintained to prevent bacterial growth, mold growth and nuisance odors.

Other Concerns

A number of other conditions that can potentially affect indoor air quality were also observed. Accumulated chalk dust was noted in several classrooms (see Picture 6).

Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several rooms had various objects hung from the ceiling tile system (see Picture 7). Building occupants should refrain from hanging objects to prevent damage to the ceiling tile system. Damaged/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors.

A number of classrooms also contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

As discussed in the Ventilation section of this report during the assessment BEHA staff, were in agreement with Pepperell Maintenance personnel that the rooftop AHU servicing the main office area be temporarily deactivated. Occupants in the main office reported chemical odors during the assessment. Measurable readings of TVOCs over background were recorded by BEHA staff in the main office and adjacent areas (see Tables). According to school maintenance officials a work crew was scheduled to conduct repairs on the rubber membrane roof. BEHA staff accompanied school maintenance officials to the roof and found the work being conducted directly below the air intake for the AHU that supplies the main office (see Picture 8). After discussion with BEHA staff and Mr. Wirtanen, school Maintenance staff immediately deactivated the unit to prevent entrainment of odors. As discussed, VOCs can be irritating to the eyes, nose and throat. Several minutes after the system was deactivated the main office was revisited. Occupants reported that the odors had ceased. Due to the rapid dissipation of

the product, any acute health effects associated with short-term exposure that may have occurred (e.g. eye, respiratory irritation), would be unlikely to result in any long term health concerns.

Finally, acids were found stored in an overhead cabinet in science prep room 301. One of the containers was not properly secured which can allow contents to off gas into occupied areas. Acid containers should be properly secured and stored in an approved acid resistant storage cabinet.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made to improve general indoor air quality:

1. It is important to note that the State Department of Education amended their regulations in 1999 to address concerns for school renovation projects in Massachusetts (MDOE, 1999). Pursuant to 603 CMR 38.00: School Construction – Massachusetts Department of Education, "[a]pplicants shall implement containment procedures for dusts, gases, fumes, and other pollutants created during renovations/construction as part of any planned construction, addition to, or renovation of a school if the building is occupied by students, teachers or school department staff while such renovation and construction is occurring. Such containment procedures shall be consistent with the most current edition of the IAQ Guidelines for Occupied Buildings Under Construction published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA). All bids received for school construction or renovations shall include the cost of planning and

execution of containment of construction/renovation pollutants consistent with the SMACNA guidelines [608 CMR 38.03(13)] General Requirements: Capital Construction" (MDOE, 1999).

2. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the *re-entrainment* of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
3. Examine rooftop exhaust motors detailed in the ventilation section of this report for proper function. Repair/replace belts and parts as necessary.
4. Continue working with current HVAC contractor to troubleshoot problems and develop a preventive maintenance plan.
5. Remove all obstructions from univent air diffusers and return vents to facilitate airflow.
6. Continue working with HVAC firm to balance the mechanical ventilation system. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
7. Faculty and staff are encouraged to report any complaints concerning temperature control/preventive maintenance issues to the facilities department via the main office.

8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Continue to work with roofing contractor to repair any existing roof leak. Once leaks are repaired, replace any remaining water-damaged building materials. Examine around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
10. Clean and maintain aquariums prevent bacterial/mold growth and/or odors.
11. Remove plants form the air stream of univents. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
12. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.
13. Refrain from hanging objects from ceiling tile system.
14. Ensure that outside contractors check in with school maintenance personnel before conducting repairs/activities that create odors, dusts fumes etc.
15. Obtain an acid storage locker for science prep rooms.
16. In order to maintain a good indoor air quality environment on the building, consideration should be give to adopting the US EPA document, “Tools for Schools”,

which can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.

17. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Gordon Air Quality Consultants, Inc. 2003. Indoor Air Quality Testing Report No. Callahan-30. Dated February 7, 2003.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

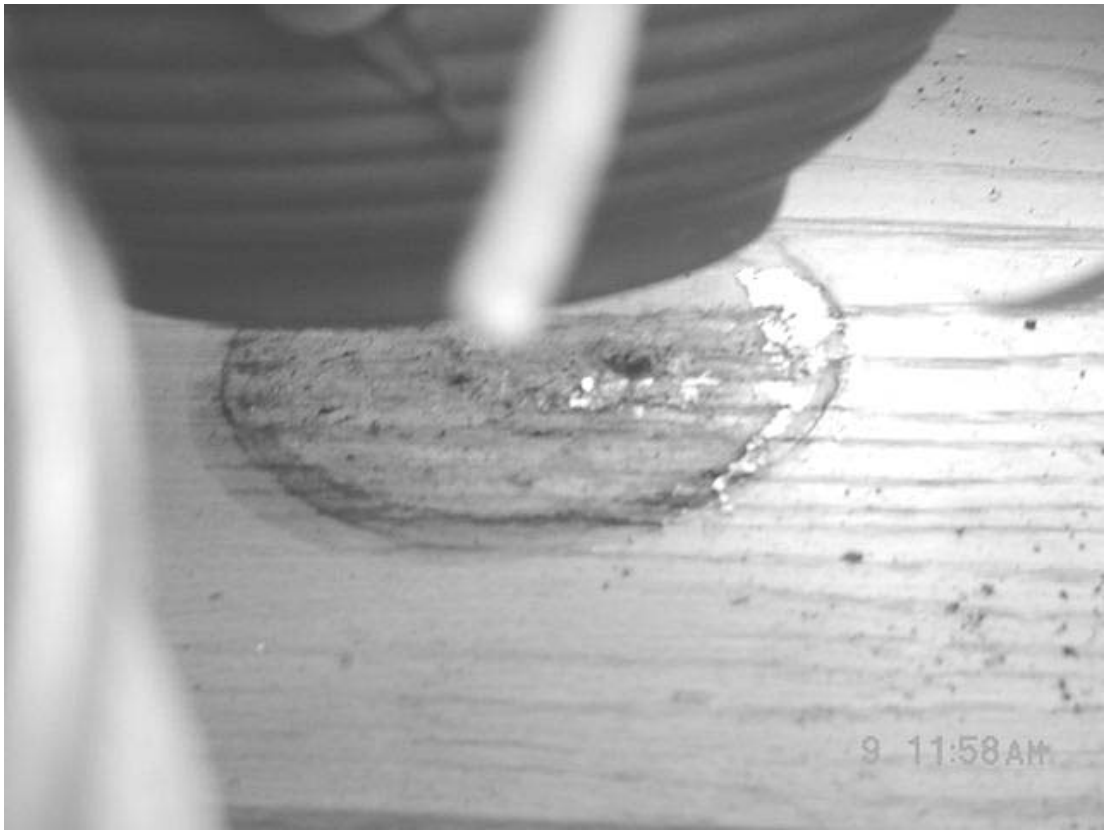
Picture 1

Univent Fresh Air Intake

Picture 2

Wall-Mounted Exhaust Vent

Picture 3



Water Pooling/Staining on Wooden Windowsill in Classroom

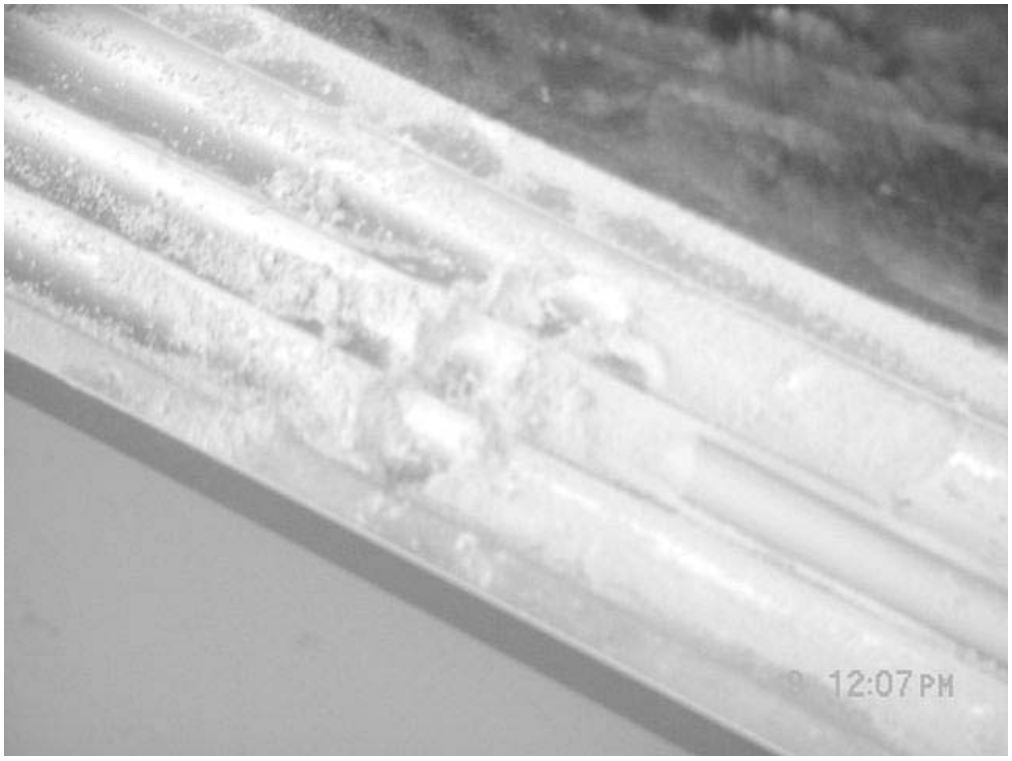
Picture 4

Plants Over Univent Air Diffusers/Items on Univent

Picture 5

Aquarium With Standing Water

Picture 6



Accumulated Chalk Dust in Classroom

Picture 7

Objects Hanging from Ceiling Tiles in Classroom

Picture 8

Air intake

Roof Repair Using VOC-containing Mastic

TABLE 1

Indoor Air Test Results – Nissitissit Middle School – Pepperell, MA — May 9, 2003

Location	Carbon Dioxide (*ppm)	TVOCs (*ppm)	Temp. (ºF)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Outside (Background)	380	0.0	72	56					Scattered clouds, morning rain, clearing sunshine, lt. Breeze
Room 300	533		76	39	1	Y	Y	Y	25 students gone for 5 min. door and window open
Room 301 Science	513		74	38	1	Y	Y	Y	24 occupants gone for 15 min rooftop unit, plants, acids stored in cabinet, rec. acid storage
Room 301	600		73	38	1	Y	Y	Y	24 occupants gone for 15 min Door and window open Plants in standing water
Room 215	628		73	39	20	Y	Y	Y	Flowering plant over UV
Room 211	663		73	38	20	Y	Y	Y	Flowering plant over UV Door/window open, exhaust vent off
Room 214	572		73	38	22	Y	Y	Y	Plants, UV return part obs, window open, items hang from CT
Room 202	638		74	38	22	Y	Y	Y	Items hang from CT Window open
Room 203	536		73	35	19	Y	Y	Y	Door/window open Items hang from CT

*** ppm = parts per million parts of air**
UV = Univent
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Nissitissit Middle School – Pepperell, MA — May 9, 2003

Location	Carbon Dioxide (*ppm)	TVOCs (*ppm)	Temp. (ºF)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Room 201	604		73	37	22	Y	Y	Y	Window open (odors)
Room 103	514		72	34	19	Y	Y	Y	Door/window open Plants – chalk dust
Room 102	624		72	39	23	Y	Y	Y	Window open
Room 101	571		71	37	20	Y	Y	Y	Plants in standing water Debris particulate
Room 100	5		71	41	23	Y	Y	Y	Door open, items hang from CT Plants over UV, debris particulate
Room 109	528		71	36	24	Y	Y	Y	Door open 25 computers
Room 112	701		78	41	25	Y	Y	Y	Door open
Room 114	709		74	39	23	Y	Y	Y	UV off/reactivated
Room 115	689		74	39	21	Y	Y	Y	Door open
Room 113	629		74	36	22	Y	Y	Y	Door open Plants
Cafeteria	667		74	34	100	Y	Y	Y	

*** ppm = parts per million parts of air**
UV = Univent
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results – Nissitissit Middle School – Pepperell, MA — May 9, 2003

Location	Carbon Dioxide (*ppm)	TVOCs (*ppm)	Temp. (ºF)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Room Medic	385		74	32	1	Y	Y	Y	
Guidance C	411		79	32	1	N	Y	Y	Heat issues 1 water-damaged CT
Room 319	461		75	29	0	Y	Y	Y	2 kilns operating, wall act switch to exhaust vents not activated/ activated by Mr. Kenison, door to kiln room open
Dark Room	507	0.0	79	33	0	N	Y	Y	Photo developer odors
Lobby		3.2-4.0							Roof patch adhesive A HV deactivated manually
Room 243	705		73	36	27	Y	Y	Y	Door open
Room 244 Music	802		73	35	22	Y	Y	Y	
Exercise Room	609	0.0	72	27	7	Y	Y	Y	Window open
Gum	513		72	56	10	Y	Y	Y	
Main Office	478		72	33	5	Y	Y	Y	

*** ppm = parts per million parts of air**
UV = Univent
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Nissitissit Middle School – Pepperell, MA — May 9, 2003

Location	Carbon Dioxide (*ppm)	TVOCs (*ppm)	Temp. (ºF)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Room 303	519		74	35	0	Y	Y	Y	Door open Desk partly blocked exhaust vent
Room 313	457		72	31	0	Y	Y	Y	Items hang from CT
Room 106	541		74	34	1	Y	Y	Y	
Auditorium	464		72	30	125	N	Y	Y	

*** ppm = parts per million parts of air**
UV = Univent
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%